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METHOD FOR WORKING AND HEAT-TREATING COPPER ALLOY FOR ELECTRIC CONNECTING MEMBER AND COPPER ALLOY FOR ELECTRIC CONNECTING MEMBER

[Denki Setsuzoku Buzai Yo Do Gokin No Kako Netsushori Hoho Oyobi Denki Setsuzoku Buzai Yo Do Gokin]

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Claims

1. A method for working and heat-treating a copper alloy for an electric connecting member, characterized by the fact that in a method for working and heat-treating a copper alloy for an electric connecting member that applies a heat treatment after molding, the above-mentioned copper alloy for an electric connecting member is worked into a spring so that the Vickers hardness (Hv) change of the worked part before and after molding is within 10; and in applying the heat treatment, the heat treatment for controlling the change of the Vickers hardness (Hv) of the above-mentioned part before and after said heat treatment to within 10 is carried out.

2. The method for working and heat-treating a copper alloy for an electric connecting member of Claim 1, characterized by the fact that the heat treatment after the above-mentioned molding is carried out at a temperature of 200-800°C for 5-10,000 sec.

3. A copper alloy for an electric connecting member, characterized by the fact that a copper alloy comprised of

[1] Numbers in the margin indicate pagination in the foreign text.

one kind or two kinds or more being selected from the following component compositions and the balance Cu and inevitable impurities is worked into a spring so that the Vickers hardness (Hv) change of the worked part before and after molding is within 10; and in applying the heat treatment, the heat treatment for controlling the change of the Vickers hardness (Hv) of the above-mentioned part before and after said heat treatment to within 10 is carried out (hereinafter, "0 wt%" means no addition).

Sn: 0-10 wt%, Zn: 0-40 wt%, Ni: 0-10 wt%

Fe: 0-3 wt%, Cr: 0-1 wt%, Mn: 0-1 wt%

P: 0-0.5 wt%, Si: 0-1 wt%, Mg: 0-1 wt%

Zr: 0-0.5 wt%, Ti: 0-1 wt%, Co: 0-1 wt%

Ag: 0-1 wt%, Al: 0-5 wt%, B: 0-0.5 wt%

Rare-earth element: 0-0.5 wt%

4. The copper alloy for an electric connecting member of Claim 3, characterized by the fact that the heat treatment after the above-mentioned molding is carried out at a temperature of 200-800°C for 5-10,000 sec.

5. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 1-4 wt% Ni, 0.1-1.0 wt% Si, and the balance Cu and inevitable impurities.

6. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 1–4 wt% Ni, 0.1–1.0 wt% Si, 0.005–1 wt% one kind or more as a total amount selected from Sn, Mn, Mg, Zn, Ag, and Co and the balance Cu and inevitable impurities.

7. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 0.5–3 wt% Sn, 0.005–0.5 wt% P, and the balance Cu and inevitable impurities.

8. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 0.5–3 wt% Sn, 0.005–0.5 wt% P, 0.005–2 wt% one kind or more as a total amount selected from Ni, Mn, Fe, Cr, Mg, and Zn and the balance Cu and inevitable impurities.

9. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 3–10 wt% Sn, 0.005–0.5 wt% P, and the balance Cu and inevitable impurities.

10. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 0-10 wt% Sn, 0.005-0.5 wt% P, 0.005-2 wt% one kind or more as a total amount selected from Ni, Fe, and Zn and the balance Cu and inevitable impurities.

11. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 5-35 wt% Zn and the balance Cu and inevitable impurities.

12. The copper alloy for an electric connecting member of Claim 3 or 4, characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 5-35 wt% Zn, 0.005-5 wt% one kind or more as a total amount selected from Sn, Ni, and Fe and the balance Cu and inevitable impurities.

3. Detailed explanation of the invention

[0001]

(Industrial application field)

The present invention pertains to a method for working and heat-treating a copper alloy for an electric connecting

member including a spring being in electric terminals, switches, etc., and the copper alloy for an electric connecting member.

[0002]

(Prior art)

Members for electric connecting members utilizing a spring characteristic of metallic materials are general, and in a so-called electric connection mechanisms of terminals and switches, an electric connection is obtained in most cases by strongly contacting with the other party material through the spring characteristic of metals. Box type terminals being frequently used in automobiles, etc., representatively have a structure as shown in Figure 1, and a tongue segment 42 of a female terminal 4 plays a role of a spring. When a male terminal 2 is inserted, the spring is deflected, and a contact force with the male terminal 2 is obtained by its repulsive force.

[0003] In order to raise the reliability of an electric contact, various approaches are made, and for example, surface enhancement by plating, etc., increase of the contact force (hereinafter, called the contact pressure), etc., are broadly employed. This contact pressure is not always constant, and “a permanent set in fatigue” is generated in a spring part by repeating the insertion and

extraction, so that a sufficient contact pressure cannot be obtained. Also, a creep is generated in a metal part, and the contact pressure is slowly reduced (stress relaxation phenomenon) in many cases.

[0004] In particular, along with the miniaturization of equipments, recently, electric connectors themselves have also been miniaturized and thinned. Even in case the same contact pressure is obtained, if plate materials are thinned, it is necessary to adopt a large amount of

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deflection of springs. The maximum stress being applied to the plate materials is considerably high, compared with the prior arts. As a result, the permanent set in fatigue is easily generated by the insertion and extraction.

[0005] Also, especially in the connectors for automobiles, the environment temperature being adopted is raised, and the stress is more easily relaxed in actuality. In consideration of the situation in which the contact pressure is easily changed with time, an especially high initial contact pressure is set so that a necessary minimum contact pressure is held over a long term.

[0006] On the other hand, the number of poles of the connectors tends to be increased with the increase of the number of input and output terminals, and the increase of

the insertion and extraction force during the insertion and extraction of the connectors becomes a problem. In other words, even if the contact pressure of a pair of connectors is slightly raised, in connectors with many poles, a necessary insertion and extraction force becomes a big change in inserting and extracting the connectors. For example, when an automobile is assembled, connectors are manually fitted. However, if the insertion and extraction force increases, the load during the assembly is increased, and the work efficiency is deteriorated.

[0007] Thus, the demand on the increase of the initial contact pressure while suppressing the insertion and extraction force low is contradictory in actuality. Needless to say, in order to suppress the insertion force low while maintaining a high contact pressure, the surface enhancement is also advanced to obtain a low friction coefficient, however a technique for making the electric reliability and the low friction coefficient compatible is not developed.

[0008]

(Problems to be solved by the invention)

The present invention considers the above situation, and its purpose is to provide a metal spring member for an electric connecting member with little change of the

contact pressure with time without raising an initial contact pressure.

[0009]

(Means to solve the problems)

A first pattern of the present invention is a method for working and heat-treating a copper alloy for an electric connecting member characterized by the fact that in a method for working and heat-treating a copper alloy for an electric connecting member that applies a heat treatment after molding, the above-mentioned copper alloy for an electric connecting member is worked into a spring so that the Vickers hardness (Hv) change of the worked part before and after molding is within 10; and in applying the heat treatment, the heat treatment for controlling the change of the Vickers hardness (Hv) of the above-mentioned part before and after said heat treatment to within 10 is carried out.

[0010] A second pattern of the present invention is a working and heat-treating method characterized by the fact that the heat treatment after the above-mentioned molding is carried out at a temperature of 200-800°C for 5-10,000 sec.

[0011] A third pattern of the present invention is a copper alloy for an electric connecting member

characterized by the fact that a copper alloy comprised of one kind or two kinds or more being selected from the following component compositions and the balance Cu and inevitable impurities is worked into a spring so that the Vickers hardness (Hv) change of the worked part before and after molding is within 10; and in applying the heat treatment, the heat treatment for controlling the change of the Vickers hardness (Hv) of the above-mentioned part before and after said heat treatment to within 10 is carried out (hereinafter, "0 wt%" means no addition).

Sn: 0-10 wt%, Zn: 0-40 wt%, Ni: 0-10 wt%

Fe: 0-3 wt%, Cr: 0-1 wt%, Mn: 0-1 wt%

P: 0-0.5 wt%, Si: 0-1 wt%, Mg: 0-1 wt%

Zr: 0-0.5 wt%, Ti: 0-1 wt%, Co: 0-1 wt%

Ag: 0-1 wt%, Al: 0-5 wt%, B: 0-0.5 wt%

Rare-earth element: 0-0.5 wt%

[0012] A fourth pattern of the present invention is an copper alloy for an electric connecting member characterized by the fact that the heat treatment after the above-mentioned molding is carried out at a temperature of 200-800°C for 5-10,000 sec.

[0013] A fifth pattern of the present invention is a copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an

electric connecting member is a copper alloy comprised of 1-4 wt% Ni, 0.1-1.0 wt% Si, and the balance Cu and inevitable impurities.

[0014] A sixth pattern of the present invention is a copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 1-4 wt% Ni, 0.1-1.0 wt% Si, 0.005-1 wt% one kind or more as a total amount selected from Sn, Mn, Mg, Zn, Ag, and Co and the balance Cu and inevitable impurities.

[0015] A seventh pattern of the present invention is a copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 0.5-3 wt% Sn, 0.005-0.5 wt% P, and the balance Cu and inevitable impurities.

[0016] An eighth pattern of the present invention is an copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 0.5-3 wt% Sn, 0.005-0.5 wt% P, 0.005-2 wt% one kind or more as a total amount selected from Ni, Mn, Fe, Cr, Mg, and Zn and the balance Cu and inevitable impurities.

[0017] A ninth pattern of the present invention is a copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 3-10 wt% Sn, 0.005-0.5 wt% P, and the balance Cu and inevitable impurities.

[0018] A tenth pattern of the present invention is a copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 0-10 wt% Sn, 0.005-0.5 wt% P, 0.005-2 wt% one kind or more as a total amount selected from Ni, Fe, and Zn and the balance Cu and inevitable impurities.

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[0019] An eleventh pattern of the present invention is a copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy comprised of 5-35 wt% Zn and the balance Cu and inevitable impurities.

[0020] A twelfth invention of the present invention is a copper alloy for an electric connecting member characterized by the fact that the above-mentioned copper alloy for an electric connecting member is a copper alloy

comprised of 5-35 wt% Zn, 0.005-5 wt% one kind or more as a total amount selected from Sn, Ni, and Fe and the balance Cu and inevitable impurities.

[0021]

(Embodiment of the invention)

As a copper alloy for an electric connecting member, it is in demand that its spring characteristic be excellent. The spring characteristic is evaluated by a spring limit value, and it is a bending stress value corresponding to the proof stress being attained from a tensile test and is defined as follows. The spring limit value (Kb) is a surface maximum stress for generating a permanent deformation equivalent to an elastic deformation when the surface stress due to bending is $3E/8 \times 10^{4}$.

[0022] As a general method for raising the spring limit value, a low-temperature annealing is known. The reason why the low-temperature annealing improves the spring limit value is considered that dislocations generated by a plastic working before the low-temperature annealing are rearranged by a heat treatment. Accordingly, in the present invention, the arrangement of the dislocations is disturbed by applying an appropriate plastic working in advance, and an appropriate low-temperature annealing is then applied, so that a copper alloy member for an electric

connecting member having an excellent spring characteristic is obtained.

[0023] A basic pattern of the present invention is a method for working and heat-treating a copper alloy for an electric connecting member characterized by the fact that in a method for working and heat-treating a copper alloy for an electric connecting member that applies a heat treatment after molding, the above-mentioned copper alloy for an electric connecting member is worked into a spring so that the Vickers hardness (Hv) change of the worked part before and after molding is within 10; and in applying the heat treatment, the heat treatment for controlling the change of the Vickers hardness (Hv) of the above-mentioned part before and after said heat treatment to within 10 is carried out. Here, in case the degree of working is determined, a thermal refining is carried out by applying an appropriate plastic working or heat treatment in advance so that the change of the hardness is within 1 when a prescribed working is carried out.

[0024] The part acting as a spring is work-hardened by bending, so that the Vickers hardness (Hv) is changed, however if the hardness change of said part exceeds 10, the characteristic as the spring cannot be sufficiently improved even by a heat treatment being applied later. The

reason for this is that the rearrangement of dislocations cannot be sufficiently realized by the subsequent low-temperature annealing.

[0025] Next, as the condition of the low-temperature annealing as a heat treatment, the reason why the heat treatment temperature is generally limited to 200-800°C is explained. At a temperature of lower than 200°C, the characteristic of the spring part cannot be improved, and at a temperature of higher than 800°C, the material to be worked is too softened. The reason why the treatment time is 5-10,000 sec is that a sufficient characteristic improvement effect is not recognized for less than 5 sec, even at a high temperature of about 800°C, for instance. Also, the treatment for more than 10,000 sec causes an excessive softening, or the effect is saturated.

[0026] In the above-mentioned treatment temperature and treatment time, their desirable conditions depend respectively on the material qualities of the copper alloy being a spring member, and representative materials and treatment conditions are explained below. As a copper alloy being used for connectors, there is a Cu-Ni-Si system alloy (called Corson alloy). An alloy that includes 1-4 wt% Ni, 0.1-1.0 wt% Si, and substantially the balance copper is known. A spring member of a copper alloy that

further includes 0.005-2 wt% one kind or more as a total amount being selected from Sn, Mn, Mg, Zn, Ag, and Co and substantially the balance copper in the above-mentioned alloy is also known. For these members, the optimum temperature is 300-750°C, and the treatment time is preferably 5-10,000 sec. In the treatment at lower than 300°C, the characteristic improvement of the spring part is not sufficient, whereas in the treatment at higher than 750°C, the hardness is as soft as 10 or more before and after the heat treatment, which is not preferable.

[0027] A brass system material being most frequently used as a copper alloy is explained. In a spring member that includes 5-35 wt% Zn and substantially the balance copper, the optimum temperature is 200-600°C, and the treatment time is preferably 5-10,000 sec. In the treatment at lower than 200°C, the characteristic improvement of the spring part is not sufficient, whereas in the treatment at higher than 600°C, the hardness is as soft as 10 or more before and after the heat treatment, which is not preferable.

[0028] Next, the heat treatment being applied after molding including bending is explained. In a strict sense, though the heat treatment conditions depend respectively on materials to be worked, if the Vickers hardness change before and after the heat treatment is generally -10-10, a

good member with little change of the contact pressure with time can be manufactured. Here, the hardness before the heat treatment is the hardness of the worked member and must be compared with the hardness after the heat treatment of the same part. If the Vickers hardness change is more than 10 and softening is caused, the permanent set in fatigue at the time of insertion and extraction and the pressure relaxation are excessive and inappropriate.

[0029] Also, like a beryllium copper, there are metallic materials to which a heat treatment for causing an age hardening is applied after molding including bending. If these metallic materials are further bent after the age hardening, the hardening is excessive, so that cracks are generated in the bent part and a normal working is impossible. For this reason, in order to prevent the cracks, the age hardening is applied after bending, however in this case, there is a large hardness change of 50 or more in the Vickers hardness (Hv). The technique for applying an age hardening after bending is different from the present invention in terms of technical meaning, and the above-mentioned technique is not included in the present invention.

[0030] As a metallic material to which the above-mentioned working and heat treatment can be applied, there is a

copper alloy. In other words, the copper alloy is a copper alloy for an electric connecting member comprised of one kind or two kinds or more being selected from the following component compositions and the balance Cu and inevitable impurities (hereinafter, “0 wt%” means no addition).

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Sn: 0-10 wt%, Zn: 0-40 wt%, Ni: 0-10 wt%
Fe: 0-3 wt%, Cr: 0-1 wt%, Mn: 0-1 wt%
P: 0-0.5 wt%, Si: 0-1 wt%, Mg: 0-1 wt%
Zr: 0-0.5 wt%, Ti: 0-1 wt%, Co: 0-1 wt%
Ag: 0-1 wt%, Al: 0-5 wt%, B: 0-0.5 wt%
Rare-earth element: 0-0.5 wt%

[0031] The above-mentioned alloy is comprehensively described. However, more specifically, copper alloys having the following component compositions are preferably applied.

There is a copper alloy for an electric connecting member characterized by being comprised of 1-4 wt% Ni, 0.1-1.0 wt% Si, and the balance Cu and inevitable impurities. This alloy is a so-called Corson alloy.

[0032] Also, as the above-mentioned copper alloy for an electric connecting member, a copper alloy comprised of 1-4 wt% Ni, 0.1-1.0 wt% Si, 0.005-1 wt% one kind or more as a

total amount selected from Sn, Mn, Mg, Zn, Ag, and Co and the balance Cu and inevitable impurities is also preferable.

[0033] Also, as the above-mentioned copper alloy for an electric connecting member, a copper alloy comprised of 0.5-3 wt% Sn, 0.005-0.5 wt% P, and the balance Cu and inevitable impurities is also preferable.

[0034] Also, as the above-mentioned copper alloy for an electric connecting member, a copper alloy comprised of 0.5-3 wt% Sn, 0.005-0.5 wt% P, 0.005-2 wt% one kind or more as a total amount selected from Ni, Mn, Fe, Cr, Mg, and Zn and the balance Cu and inevitable impurities is also preferable.

[0035] Also, as the above-mentioned copper alloy for an electric connecting member, a copper alloy comprised of 3-10 wt% Sn, 0.005-0.5 wt% P, and the balance Cu and inevitable impurities is also preferable.

[0036] Furthermore, as the above-mentioned copper alloy for an electric connecting member, a copper alloy comprised of 0-10 wt% Sn, 0.005-0.5 wt% P, 0.005-2 wt% one kind or more as a total amount selected from Ni, Fe, and Zn and the balance Cu and inevitable impurities can be mentioned.

[0037] Furthermore, as the above-mentioned copper alloy for an electric connecting member, a copper alloy comprised of

5-35 wt% Zn and the balance Cu and inevitable impurities can also be used.

[0038] Furthermore, as the above-mentioned copper alloy for an electric connecting member, a copper alloy comprised of 5-35 wt% Zn, 0.005-5 wt% one kind or more as a total amount selected from Sn, Ni, and Fe and the balance Cu and inevitable impurities can also be used.

[0039]

Application Example 1

Materials with a plate thickness of 0.25 mm as copper alloys (A: Corson alloy, B and C: bronzes, and D: brass) with component compositions described in Table 1 shown as Figure 4 were worked into male terminals with a shape shown in Figure 1 and heat-treated under the conditions of Table 2 shown as Figure 5. Conventional examples are the cases where no heat treatment is applied, and comparative examples are the cases where the temperature or heat treatment time is inappropriate. The heat treatment was carried out in a sealed small-scale electric furnace that enables rapid heating and rapid cooling. The heat treatment was carried out in a nonoxidizing atmosphere in a state in which a thermocouple was mounted in the materials to be worked.

[0040] As the characteristic evaluation, hardness, permanent set in fatigue of the spring part, and stress relaxation characteristic were evaluated. Each evaluation method is described below.

<Hardness> The hardness is required to be measured by using the bent part acting as a spring. When the hardness of the bent part was measured, the materials to be worked were buried into a resin and polished, and the cross section was measured. Three positions in the part at the outside in the bending radial direction from the plate thickness center of the bent cross section were measured. Also, three positions of the unbent part were measured. From each average value, the hardness change before and after bending was attained. Next, the Vickers hardness (Hv) after the heat treatment was measured. The hardness measurement part is the above-mentioned bent part. The hardness change before and after the heat treatment was attained by the difference of the average of three points

[0041] <Permanent set in fatigue of spring part> For five samples after the heat treatment, the interval of the gap (1) shown in Figure 1 was measured several times, and its average value A was attained. Also, for five samples in which a male tab was pulled out after holding for 60 sec, the interval of the gap (1) was measured several times.

Then, the difference between A and B was attained and assumed as the permanent set in fatigue of the spring part after inserting and extracting the male tab.

[0042] <Stress relaxation characteristic> For five samples after the heat treatment, the male tab was inserted into them, and in this state, a relaxation treatment at 150°C for 500 h were carried out. After a lapse of 500 h, the samples were drawn out of the treatment furnace, and the male tab was pulled out. The interval of the gap (1) shown in Figure 1 was measured, the average value C of five samples were attained, and the above-mentioned difference between A and C was attained and adopted as the amount of relaxation.

[0043] The above-mentioned gap was measured by burying the terminal into a resin and observing the cross section after polishing. The above-mentioned measurement results were described in Table 3 shown as Figure 6. Also, in the bent part of this application example, the hardness change before and after bending was within 10 in any of the materials A-D. According to Table 3 of Figure 6, in Conventional Examples Nos. 14-17 in which no heat treatment is applied after molding including bending, both the permanent fatigue of the spring part and the amount of stress relaxation are inferior. In Examples Nos. 1-13 of

the present invention in which a heat treatment is applied after molding, it is understood that very excellent characteristics are shown.

[0044] Also, in Nos. 19, 20, 23, 25, and 27 with high heat treatment temperature, the hardness after the heat treatment is Hv of 10 or more, and softening is caused, compared with the hardness before the heat treatment. It is understood that the permanent set in fatigue of the spring part and the amount of relaxation are largely degraded. Thus, it is important to apply the heat treatment to the degree that the material to be worked is not too softened, and its optimum heat treatment conditions depend on the materials.

[0045]

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Application Example 2

Specimens (イ, ロ, ハ) with different hardness change in bending of the above-mentioned material C were prepared and subjected to the same test as that of Application Example 1. The heat treatment conditions were the same as the conditions of No. 10 shown in Application Example 1. The results are shown in Table 4 as Figure 7. In No. 30 that was originally soft, the hardness change after bending was 12, and the characteristic as a spring was inferior to

that of Nos. 28 and 29 as examples of the present invention. In other words, the hardness change in bending depends on the heat treatment conditions of the specimens before bending, even in the same working, and the spring characteristic is inferior under conditions out of the range of the present invention. Hereto, the present invention has been explained by only the copper alloys, however in principle, for example, the present invention can also be applied to carbon steels, stainless steels, etc.

[0046]

(Effects of the invention)

As mentioned above in detail, if the working and heat-treating method of the present invention is applied to copper alloys for an electric connecting member, the permanent set in fatigue and the stress relaxation characteristic of the spring part are improved, so that the contact pressure can always be highly held. Also, since the change of the contact pressure with time is little, an especially high initial contact pressure is not required to be set, being able to contribute to the decrease of the insertion force. Also, the copper alloys to which the above-mentioned working and heat-treating method is applied can be used as electric connecting members over a long

term. Therefore, the present invention greatly contributes to industrial usages.

Brief description of the figures

Figure 1 shows a shape example of an electric connecting member including a spring.

Figure 2 shows a state in which a male part and a female part of the electric connecting member are connected.

Figure 3 shows the part in which the hardness of a bent member is measured.

Figure 4 shows a tested alloy component composition as Table 1.

Figure 5 shows a tested heat treatment temperature as Table 2.

Figure 6 shows the hardness change, the permanent set in fatigue of the spring part, and the amount of relaxation before and after the tested heat treatment.

Figure 7 shows the relationship between the hardness change and the spring characteristic before and after bending in the case where bending into a spring is carried out by Table 4.

Explanation of numerals:

2 Male terminal of connecting part

4 Female terminal of connecting part

42 Tongue segment of female terminal

(A)

Figure 1:

(A)

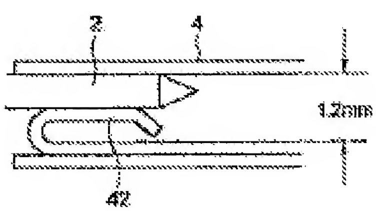
2 Male terminal of connecting part

4 Female terminal of connecting part

42 Tongue segment of female terminal

(B)

(1) Gap



【図3】

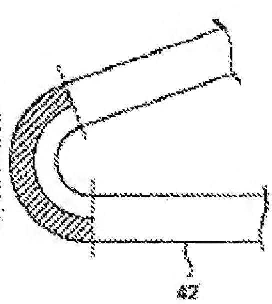


Figure 3:

1. Hardness measurement part

(B)

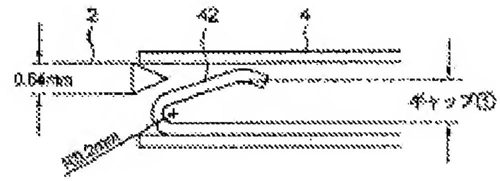


表1

	成分 (wt%)
A材	Cu-2.5%Ni-0.6%Si-0.5%Zn-0.2%Sn-0.1%Mg
B材	Cu-2%Sn-1%Ni-0.05%P
C材	Cu-8%Sn-0.05%P
D材	Cu-30%Zn

Figure 4:

1. Component (wt%)
2. A material
3. B material
4. C material
5. D material

表4

	No.	使用材	調質	曲げ加工前後硬さ変化(Hv)	熱処理前後硬さ変化(Hv)	ばね部へたり (mm)	[illegible] (mm)
本発明例	18	C材	イ	3	-4	0.05	0.14
	19	C材	ロ	6	-5	0.03	0.12
比較例	20	C材	ハ	18	-8	0.21	[illegible]

Figure 7:

1. Material used
2. Thermal refining
3. Hardness change (Hv) after bending
4. Hardness change (Hv) after heat treatment
5. Permanent set in fatigue of spring part (mm)

6. Amount of relaxation (mm)

7. Example of the present invention

8. Comparative example

9. C material

表2

	No.	使用材	熱処理条件	
			温度(℃)	時間(sec)
本発明	1	A材	400	3600
	2	A材	400	60
	3	A材	400	300
	4	A材	450	300
	5	A材	500	300
	6	A材	650	10
	7	B材	280	3600
	8	B材	350	300
	9	B材	450	300
	10	C材	330	300
	11	C材	400	60
	12	D材	230	300
	13	D材	350	60
従来例	14	A材	熱処理無し	
	15	B材	熱処理無し	
	16	C材	熱処理無し	
	17	D材	熱処理無し	
比較例	18	A材	250	3600
	19	A材	820	5
	20	A材	800	2
	21	A材	350	18000
	22	B材	220	7200
	23	B材	730	5
	24	C材	180	7200
	25	C材	650	5
	26	D材	180	7200
	27	D材	630	5

Figure 5:

1. Material used

2. Heat treatment conditions

3. Temperature (°C)

4. Time (sec)

5. Present invention

6. Conventional example

7. Comparative example

8. No heat treatment

9. Material

表3

	No.	使用材	熱処理前後硬さ変化(Hv)	ばね部へたり(mm)	緩和量(mm)
本発明	1	A材	3	0.04	0.09
	2	A材	-1	0.06	0.12
	3	A材	1	0.05	0.10
	4	A材	2	0.05	0.09
	5	A材	-1	0.04	0.08
	6	A材	-3	0.05	0.10
	7	B材	-3	0.06	0.13
	8	B材	-2	0.07	0.13
	9	B材	-4	0.06	0.12
	10	C材	-2	0.05	0.14
	11	C材	-4	0.06	0.15
	12	D材	-3	0.08	0.18
	13		-3	0.09	0.19
従来例	14	A材	—	0.09	0.17
	15	B材	—	0.11	0.20
	16	C材	—	0.10	0.22
	17	D材	—	0.13	0.23
比較例	18	A材	1	0.08	0.16
	19	A材	-105	0.21	0.32
	20	A材	-47	0.19	0.29
	21	A材	4	0.08	0.13
	22	B材	0	0.11	0.21
	23	B材	-34	0.25	0.37
	24	C材	-1	0.09	0.22
	25	C材	-69	0.29	0.41
	26	D材	-3	0.13	0.28
	27	D材	-44	0.27	0.49

Figure 6:

1. Material used

2. Hardness change (Hv) after heat treatment

3. Permanent set in fatigue of spring part (mm)

4. Amount of relaxation (mm)

5. Present invention

6. Conventional example

7. Comparative example

8. Material